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Requested Patent: GB2249448A

Title: STEPPED FREQUENCY RADAR ;

Abstracted Patent: GB2249448 ;

Publication Date: 1992-05-06 ;

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Applicant(s): ROKE MANOR RESEARCH (GB) ;

Application Number: GB19900023619 19901030 ;

Priority Number(s): GB19900023619 19901030 ;

IPC Classification: G01S13/34 ;

Equivalents: ;

ABSTRACT:

A radar system suitable for short range operation includes a radar transmitter and a radar receiver the radar transmitter comprising an FM modulator 7, 6, 2 adapted to provide stepped frequency modulation (F1-F6 Fig 2a) of a transmitted carrier wave between a plurality of different frequencies wherein the duration T of the steps is such in relation to the range of a target to be detected that demodulated radar echo signals (F1-F5 Fig 2b) received from the target differ in frequency as compared with the frequency of the contemporaneously transmitted radar modulation signals. The first IF on line 11 is synchronously demodulated in I and Q channels, which are each mixed with a frequency equal to the step frequency to provide baseband signals digitally processed to provide the range indication.

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G01S 13/34

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H4D DRPS D380

(56) Documents cited
GB 1434532 A GB 1333369 A US 4689489 A

(58) Field of search
UK CL (Edition K) H4D DRPN DRPS DSPS
INT CL5 G01S
Online databases: WPI, CLAIMS, INSPEC.

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(54) Stepped frequency radar

(57) A radar system suitable for short range operation includes a radar transmitter and a radar receiver the radar transmitter comprising an FM modulator 7, 6, 2 adapted to provide stepped frequency modulation (F_1-F_6 Fig 2a) of a transmitted carrier wave between a plurality of different frequencies wherein the duration T of the steps is such in relation to the range of a target to be detected that demodulated radar echo signals (F_1-F_5 Fig 2b) received from the target differ in frequency as compared with the frequency of the contemporaneously transmitted radar modulation signals. The first IF on line 11 is synchronously demodulated in I and Q channels, which are each mixed with a frequency equal to the step frequency to provide baseband signals digitally processed to provide the range indication.

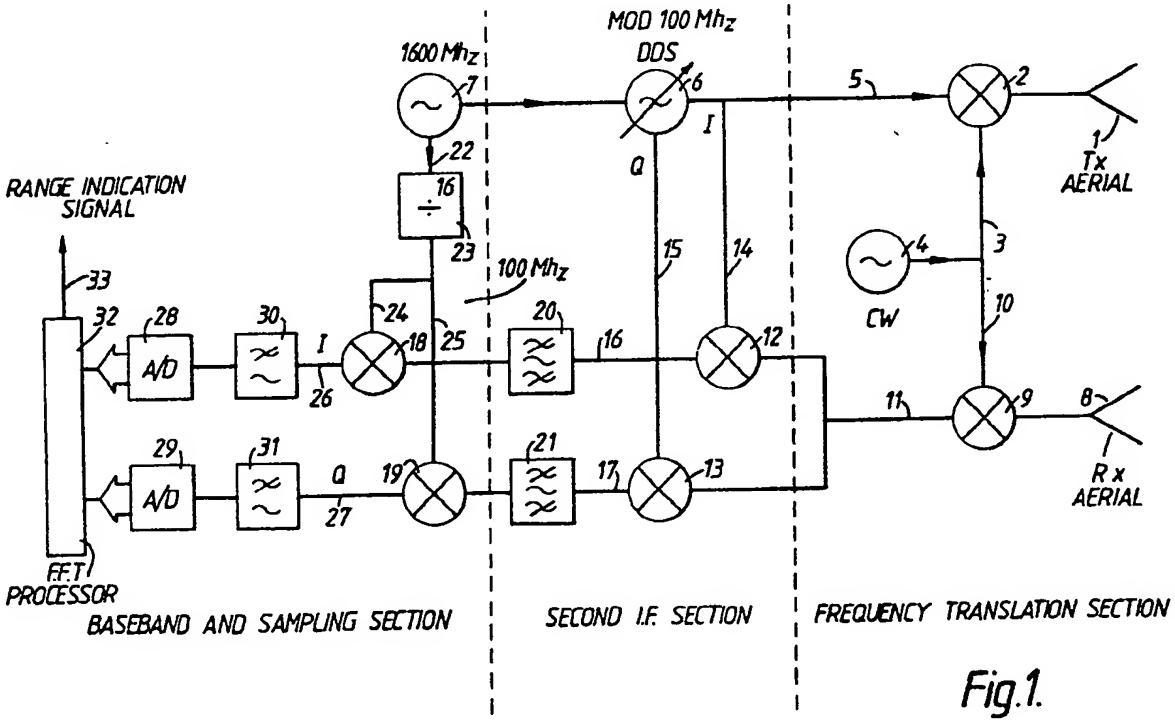

Fig.1.

GB 2 249 448 A

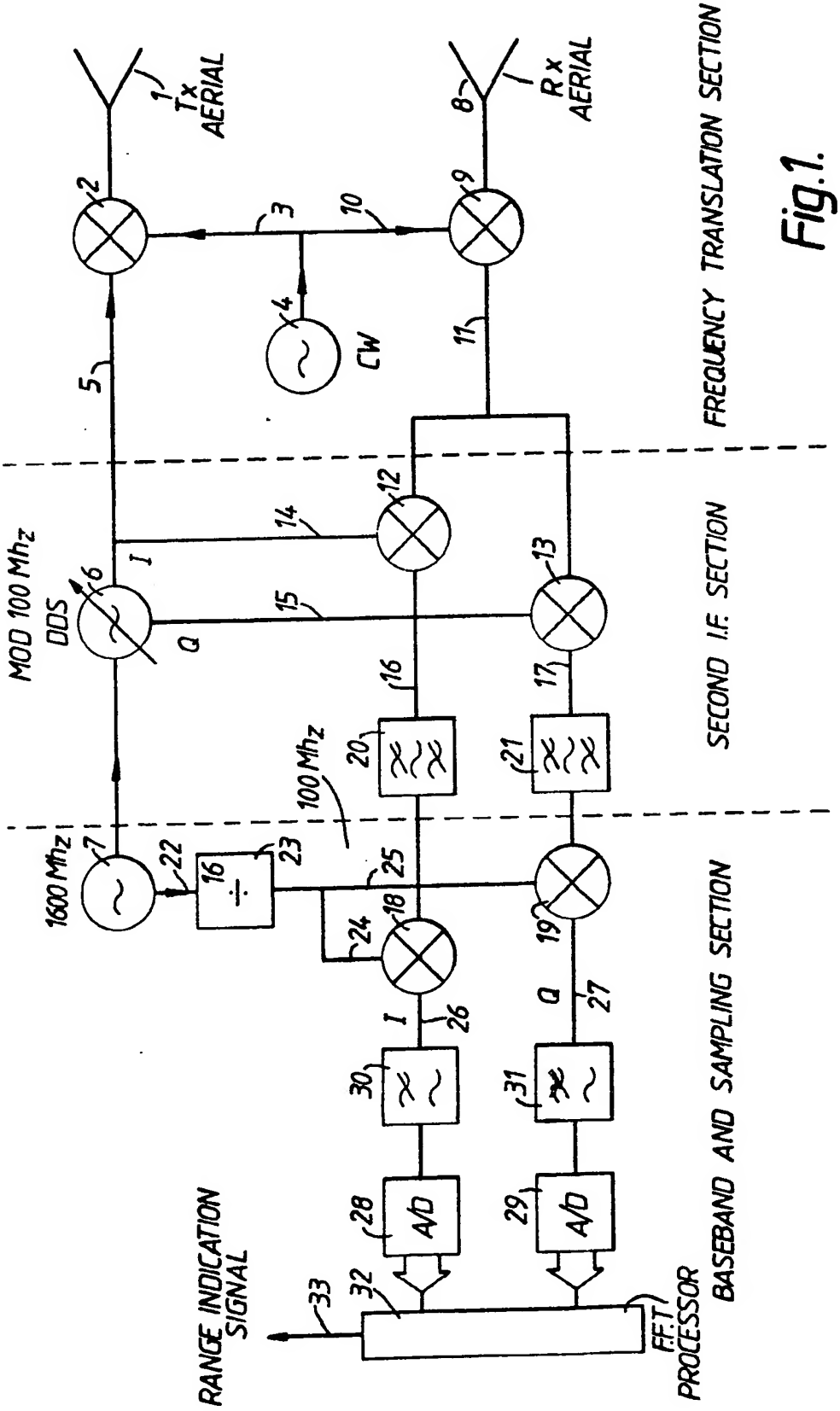
1 Tx AERIAL
8 Rx AERIAL
2
3
10
9
4 CW
5
11
FREQUENCY TRANSLATION SECTION
MOD 100 Mhz
DDS
6
I
Q
14
15
12
13
16
17
20
21
100 Mhz
SECOND I.F. SECTION
1600 Mhz
7
22
16
23
25
24
18
19
I
Q
26
27
30
31
28
29
A/D
A/D
32
33
RANGE INDICATION SIGNAL
F.F.T. PROCESSOR
BASEBAND AND SAMPLING SECTION

Fig.1.

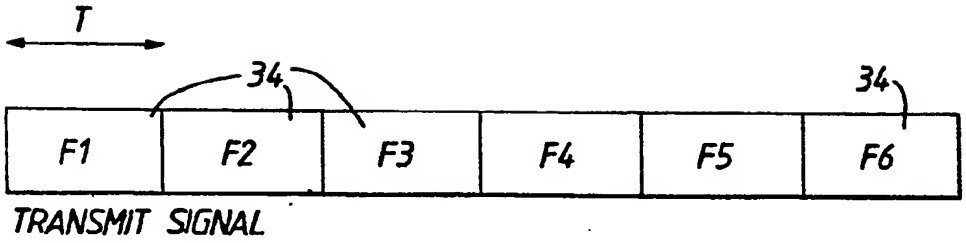
T
34
34
F1
F2
F3
F4
F5
F6
TRANSMIT SIGNAL

Fig.2a.


F1
F2
F3
F4
F5
RECEIVE SIGNAL FOR TARGET AT MATCHED RANGE

Fig.2b.

IMPROVEMENTS IN OR RELATING TO RADAR SYSTEMS

This invention relates to radar systems and more especially it relates to radar systems suitable for short range applications, e.g. systems capable of operation at ranges of 20 metres or less for example.

Short range radar systems are known which use very short pulses but the use of very short radar pulses introduces problems due to the fact that the short pulse length required for very short range operation may require pulses which are so short as to be impracticable.

Systems are also known which use a continuous c.w. (carrier wave) radar signal but these known radar systems have the disadvantage that the detection of radar echo signal returns at very short ranges is difficult in the presence of a much stronger radiated c.w. radar signal.

According to the present invention a radar system suitable for short range operation includes a radar transmitter and a radar receiver the radar transmitter comprising an FM modulator adapted to provide stepped frequency modulation of a transmitted carrier wave between a plurality of different frequencies wherein the duration of the steps is such in relation to the range of a target to be detected that radar echo signals received from the target differ in frequency as compared with the frequency of contemporaneously transmitted radar signals whereby detection of the echo signals at the radar receiver is facilitated.

Thus it will be appreciated that when the duration of each step is "range matched" (i.e. when the range of the target is such in relation to the duration of each step that during the period of transmission of each step echo signals from a preceding step are contemporaneously received) echo signals will be at a frequency which differs from the contemporaneously transmitted frequency for the duration of each step whereby the echo signal detection is facilitated.

Two different frequencies may be transmitted alternately whereby range matching at a particular range is afforded and at odd multiples of that range.

Alternatively several different frequencies may be transmitted sequentially in steps, the frequency steps being repeated whereby target range is indicated in accordance with the contemporaneous frequency difference between a transmitted radar signal and a received radar echo signal return and such that range matching will be afforded at a different range for each frequency and at multiples of that range.

The FM modulator may comprise a mixer fed with a signal from a carrier frequency generator and also with a modulation signal from a modulation signal generator thereby to provide the radar signal for transmission and the radar receiver may comprise a first mixer fed with received echo signals and with a signal from a carrier frequency generator thereby to provide a first IF signal, a pair of mixers fed with the first IF signal and fed respectively with phase quadrature related samples of the modulation signal thereby to provide second IF I and Q channels one from each mixer of the pair,

a baseband demodulator to which the I and Q channels are fed and a signal processor responsive to the baseband demodulator for providing a signal in dependence upon target range.

The baseband demodulator may comprise a further pair of mixers to which the second IF I and Q channels are fed one to each mixer, a signal generator which serves to provide a local oscillator signal for the further pair of mixers and which provides a reference signal for the modulation signal generator and a pair of analogue to digital converters via which signals from the said further pair of mixers are fed to the signal processor.

The said further pair of mixers may each be fed via bandpass filters and the said analogue to digital converters may each be fed by low pass filters.

One embodiment of the invention will now be described by way of example with reference to the accompanying drawing in which;

Figure 1 is a generally schematic block circuit diagram of a radar system and wherein;

Figure 2 is a diagram showing the relationship between transmit and received signals at "matched range".

Referring now to Figure 1, a radar system comprises a transmission aerial 1 which is fed with a frequency modulated transmission signal from a mixer 2. The mixer 2 is fed with a microwave carrier signal on a line 3 from a carrier signal frequency generator 4 and with a stepped frequency modulation signal on a line 5 from a frequency modulation signal generator 6. The modulation signal generator 6 takes the form in this example of a

direct digital synthesiser which is fed with a reference signal from a reference signal generator 7. In one example the frequency of the reference signal generator may be say 1600MHz which is fed to the direct digital synthesiser forming the modulation signal generator 6 which produces a 100MHz signal on the line 5 for the mixer 2. The carrier wave signal generator 4 might typically operate at 2GHz whereby a transmitted radar signal is produced at the aerial of 2GHz frequency modulated in 100MHz steps. Echo signal returns are received by a receiver aerial 8 signals from which are fed to a mixer 9. The mixer 9 is fed with a local oscillator signal on a line 10 from the carrier wave generator 4 thereby to produce a first IF signal on a line 10 which is fed to a pair of mixers 12 and 13. The mixers 12 and 13 are fed on lines 14 and 15 respectively with quadrature related I and Q signals thereby to produce second intermediate frequency signals on lines 16 and 17 which are fed to a further pair of mixers 18 and 19 respectively via bandpass filters 20 and 21. A 1600MHz signal from the reference oscillator 7 is fed via a line 22 to a division unit 23 which divides by 16 to produce a 100MHz reference signal on lines 24 and 25 for the further pair of oscillators 18 and 19 respectively. Base band I and Q signals are fed from the mixers 18 and 19 on lines 26 and 27 respectively to A to D converters 28 and 29 via low pass filters 30 and 31. Digital I and Q base band signals are fed to a signal processor 32 which serves to provide on line 33 an output signal indicative of range.

As shown in Figure 2 the transmitted signal is switched through six steps F1 to F6 such that it increases in frequency by 100MHz at each step. As shown in Figure 2b, received signal echos

from a target at matched range will be such that when the signal F2 is transmitted echo signals at F1 will be received. Thus at matched range, there will always be a frequency differential between returning echo signals and the transmitted signal. It will therefore be appreciated that the pulse length T as shown in Figure 2 may be controlled so that at a specified range corresponding to matched range, returning echo signals are of different frequency to the transmitted signal whereby interference therebetween is minimised and target detection is facilitated.

Various modifications may be made to the system hereinbefore described without departing from the scope of the invention and for example it will be appreciated that different frequency ranges may be chosen in accordance with the application in view.

CLAIMS

1. A radar system suitable for short range operation including a radar transmitter and a radar receiver the radar transmitter comprising an FM modulator adapted to provide stepped frequency modulation of a transmitted carrier wave between a plurality of different frequencies wherein the duration of the steps is such in relation to the range of a target to be detected that radar echo signals received from the target differ in frequency as compared with the frequency of contemporaneously transmitted radar signals whereby detection of the echo signals at the radar receiver is facilitated.

2. A radar system as claimed in claim 1 wherein two different frequencies are transmitted alternately whereby range matching at a particular range is afforded and at odd multiples of that range.

3. A radar system as claimed in claim 1 wherein several different frequencies are transmitted sequentially in steps, the frequency steps being repeated whereby target range is indicated in accordance with the contemporaneous frequency difference between a transmitted radar signal and a received radar echo signal return and such that range matching will be afforded at a different range for each frequency and at multiples of that range.

4. A radar system as claimed in any preceding claim, wherein the FM modulator comprises a mixer fed with a signal from a carrier frequency generator and also with a modulation signal from a

modulation signal generator thereby to provide the radar signal for transmission and the radar receiver may comprise a first mixer fed with received echo signals and with a signal from a carrier frequency generator thereby to provide a first IF signal, a pair of mixers fed with the first IF signal and fed respectively with phase quadrature related samples of the modulation signal thereby to provide second IF I and Q channels one from each mixer of the pair, a baseband demodulator to which the I and Q channels are fed and a signal processor responsive to the baseband demodulator for providing a signal in dependence upon target range.

5. A radar system as claimed in claim 4 wherein the baseband demodulator comprises a further pair of mixers to which the second IF I and Q channels are fed one to each mixer, a signal generator which serves to provide a local oscillator signal for the further pair of mixers and which provides a reference signal for the modulation signal generator and a pair of analogue to digital converters via which signals from the said further pair of mixers are fed to the signal processor.

6. A radar system as claimed in claim 4 or claim 5 wherein said further pair of mixers are each fed via bandpass filters and the said analogue to digital converters are each be fed by low pass filters.

7. A radar system substantially as hereinbefore described with reference to the accompanying drawings.

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Patents Act 1977
Examiner's report to the Comptroller under Section 17 (The Search Report)

Application number: 9023619.1

Relevant Technical fields

(i) UK Cl (Edition K) DRPS, DRPN, DSPS

(ii) Int Cl (Edition 5) G01S

Search Examiner: G A McLEAN

Databases (see over)

(i) UK Patent Office

(ii) ONLINE DATABASES WPI, CLAIMS, INSPEC

Date of Search: 12.2.91

Documents considered relevant following a search in respect of claims 1-7

Category (see over)	Identity of document and relevant passages	Relevant to claim(s)
X,Y	GB 1434532 A (DECCA) whole document	1-3
X,Y	GB 1333369 A (BENDIX) whole document	1-3
X,Y	US 4689489 (SHELL) whole document	1-3

Category	Identity of document and relevant passages	Relevant to claim(s)

Categories of documents

X: Document indicating lack of novelty or of inventive step.

Y: Document indicating lack of inventive step if combined with one or more other documents of the same category.

A: Document indicating technological background and/or state of the art.

P: Document published on or after the declared priority date but before the filing date of the present application.

E: Patent document published on or after, but with priority date earlier than, the filing date of the present application.

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Databases: The UK Patent Office database comprises classified collections of GB, EP, WO and US patent specifications as outlined periodically in the Official Journal (Patents). The on-line databases considered for search are also listed periodically in the Official Journal (Patents).

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